

Recent NIOSH Publications – updated 06/09/2015

Select 2015 Publications

Albers J, Lowe B, Lipscomb H, Hudock S, Dement J, Evanoff B, . . . Schoenfisch A. (2015). Pneumatic nail guns: Revisiting trigger recommendations. *Professional Safety*, 60(3), 30-33.
<http://www.asse.org/professionalsafety/search/index3.php>

Pneumatic nail guns have a safety device (workpiece contact, nose, yoke, tip) at the end of the gun muzzle that must be depressed before the fastener can be discharged. Two types of trigger systems define how the nail gun fires in response to a trigger press: 1) The sequential actuation trigger requires that each nail can only be discharged when the safety tip is first depressed and, while held depressed, the trigger is squeezed, and 2) the contact actuation trigger allows the operator to first squeeze the trigger and, while holding the trigger squeezed, repeatedly bump the safety tip on the workpiece to shoot multiple nails. Of these two trigger mechanisms, the first provides a positive safety advantage in that it prevents the unintended firing of a nail that can otherwise occur when the trigger is depressed and the workpiece contact is bumped.

Hewitt S, Dong RG, Welcome DE, McDowell TW. (2015). Anti-vibration gloves? *Annals of Occupational Hygiene* 59(2): 127-141.

For exposure to hand-transmitted vibration (HTV), personal protective equipment is sold in the form of anti-vibration (AV) gloves, but it remains unclear how much these gloves actually reduce vibration exposure or prevent the development of hand-arm vibration syndrome in the workplace. This commentary describes some of the issues that surround the classification of AV gloves, the assessment of their effectiveness and their applicability in the workplace. The available information shows that AV gloves are unreliable as devices for controlling HTV exposures. Other means of vibration control, such as using alternative production techniques, low-vibration machinery, routine preventative maintenance regimes, and controlling exposure durations are far more likely to deliver effective vibration reductions and should be implemented.

Krajnak K, Waugh S, Johnson C, Miller RG, Welcome D, Xu X, Warren C, Sarkisian S, Andrew M, Dong RG. (2015). Antivibration gloves: Effects on vascular and sensorineural function, an animal model. *Journal of Toxicology and Environmental Health* 78(9): 571-582.

The goal of this study was to use a characterized animal model of vibration-induced peripheral vascular and nerve injury to determine whether anti-vibration materials reduced or inhibited the effects of vibration on these physiological symptoms. The study's findings are consistent with experimental findings in humans suggesting that anti-vibration gloves may not provide protection against the adverse health consequences of vibration exposure in all conditions.

Lowe BD, Swanson NG, Hudock SD, Lotz WG. (2015). Unstable sitting in the workplace—Are there physical activity benefits? *American Journal of Health Promotion: AJHP*, 29(4), 207-209. doi: 10.4278/ajhp.140331-CIT-127

The increasingly popular practice of using a stability ball (exercise/fitness ball) as a sitting surface runs counter to conventional human factors/ergonomics guidelines for seated workspace design. Published studies and best evidence to date call into question even the theoretical basis for this practice and do not suggest significant health benefits. Until studies demonstrate more conclusive benefits, the practice of stability ball sitting should be viewed skeptically as a general workplace recommendation in the interest of health or wellness.

Lu ML, Waters T, Werren D. (2015). Development of human posture simulation method for assessing posture angles and spinal loads. *Human Factors and Ergonomics in Manufacturing & Service Industries* 25: 123–136. doi: 10.1002/hfm.20534

A human posture simulation method of estimating multiple body postural angles and spinal loads from a video record was developed to expedite ergonomic assessments. The posture simulation method enables researchers to quantify simultaneously body posture angles and spinal loading variables with accuracy and precision comparable to

on-screen posture-matching methods.

Lu ML, Kincl L, Lowe B, Succop P, Bhattacharya A. (2015). Muscular activity of lower limb muscles associated with working on inclined surfaces. *Ergonomics*, 58(2), 278-290. doi: 10.1080/00140139.2014.968634

This study investigated the effects of visual cues, muscular fatigue, task performance and experience of working on inclined surfaces on activity of postural muscles in the lower limbs associated with maintaining balance on three inclined surfaces - 0°, 14° and 26°. Results showed that inclination angle and task performance caused a significant increase in the normalized electromyographic amplitudes of all postural muscles. Input of visual cues while working on inclined surfaces may provide beneficial effects on reducing muscular loading to prevent occupational falls.

McDowell TW, Warren C, Xu XS, Welcome DE, and Dong RG. (2015) Laboratory and Workplace Assessments of Rivet Bucking Bar Vibration Emissions. *Annals of Occupational Hygiene* 59(3): 382–397.

This study included the development of a laboratory-based method for assessing bucking bar vibrations which utilizes a simulated riveting task. With this method, this study evaluated three traditional steel bucking bars, three similarly shaped tungsten alloy bars, and three bars featuring spring-dampeners. For comparison the bucking bar vibrations were also assessed during three typical riveting tasks at a large aircraft maintenance facility. The newer bucking bar technologies exhibited significantly reduced vibrations compared to the traditional steel bars.

NIOSH [2015]. Health hazard evaluation report: evaluation of carpal tunnel syndrome and other musculoskeletal disorders among employees at a poultry processing plant. By Ramsey J, Musolin K, Mueller C. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HHE Report No. 2014-0040-3232. <http://www.cdc.gov/niosh/hhe/reports/pdfs/2014-0040-3232.pdf>

Waters TR, Dick RB. (2015). Evidence of health risks associated with prolonged standing at work and intervention effectiveness. *Rehabilitation Nursing*, 40(3), 148-165. doi:<http://dx.doi.org/10.1002/rnj.166>

Prolonged standing at work has been shown to be associated with a number of potentially serious health outcomes, such as lower back and leg pain, cardiovascular problems, fatigue, discomfort, and pregnancy-related health outcomes. Review of the literature supports the conclusion that certain interventions are effective in reducing the hazards associated with prolonged standing. Use of interventions and following suggested guidelines on hours of standing from governmental and professional organizations should reduce the health risks from prolonged standing.

Welcome DE, Dong RG, Xu XS, Warren C, McDowell TW and Wu JZ. (2015). An Examination of the Vibration Transmissibility of the Hand-Arm System in Three Orthogonal Directions. *International Journal of Industrial Ergonomics* 45: 21-34.

For the first time, the transmitted vibrations distributed on the entire hand-arm system exposed in the three orthogonal directions via a 3-D vibration test system were measured using a 3-D laser vibrometer. The characterization of the vibration transmissibility of the system can help understand hand-arm vibration syndrome and help develop improved frequency weightings for assessing the risk of the exposure for developing various components of the syndrome.

Wu JZ, Sinsel E, Zhao K, An KN, Buczek FL. (2015). Analysis of the constraint joint loading in the thumb during pipetting. *J Biomech Eng*. doi:10.1115/1.4030311.

Dynamic loading on articular joints is essential for the evaluation of the risk of the articulation degeneration associated with occupational activities. The dynamic constraint loading for the thumb during pipetting was analyzed. Our analysis indicated that the thumb joints are subjected to repetitive, intensive loading during pipetting, compared to other daily activities.

Select 2014 Publications

Albers JT, Hudock SD, Lowe BD. (2014). Residential building stakeholders' attitudes and beliefs regarding nail gun injury risks and prevention. *NEW SOLUTIONS: A Journal of Environmental and Occupational Health Policy*, 23(4), 577-605. doi: 10.2190/NS.23.4.d

Pneumatic nail guns are ubiquitous at residential construction sites across the United States. Different trigger mechanisms on these tools are associated with different levels of risk. Residential building subcontractors and workers, both native-born and immigrant, were brought together in focus groups to discuss their attitudes and beliefs regarding risk factors for nail-gun injury as well as barriers to the adoption of safer technology. Participants attributed influences on injury risk to personal and external causation factors in all sociotechnical system categories; however, participants more frequently described influences on injury prevention as related to workers' behaviors, rather than to external factors. A discussion of these influences with respect to attribution theory and sociotechnical models of injury causation is presented.

Dong RG, Welcome DE, Peterson DR, Xu XS, McDowell TW, Warren C, Asaki T, Kudernatsch S, Brammer A. (2014). Tool-Specific Performance of Vibration-Reducing Gloves for Attenuating Palm-Transmitted Vibrations in Three Orthogonal Directions. *International Journal of Industrial Ergonomics* 44: 827-839.

Vibration-reducing (VR) gloves have been increasingly used to help reduce vibration exposure, but it remains unclear how effective these gloves are. The purpose of this study was to estimate tool-specific performances of VR gloves for reducing the vibrations transmitted to the palm of the hand in three orthogonal directions (3-D). This study provides useful information on the effectiveness of VR gloves when used with many tools for reducing the 3-D vibration transmitted to the palm. The results can aid in the appropriate selection and use of these gloves.

Garg A, Kapellusch JM, Hegmann KT, Moore JS, Boda S, Bhoyar P, . . . Malloy EJ. (2014). The NIOSH lifting equation and low-back pain, part 2: Association with seeking care in the BackWorks prospective cohort study. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 56(1), 44-57. doi: 10.1177/0018720813491284

This article describes a prospective cohort study using the revised NIOSH lifting equation to predict the risk of seeking care for low-back pain (SC-LBP). Peak lifting index (PLI) and peak cumulative lifting index (PCLI) were significantly associated with increased risk of SC-LBP. PLI and PCLI are useful metrics for estimating exposure to biomechanical stressors.

Garg A, Boda S, Hegmann KT, Moore JS, Kapellusch JM, Bhoyar P, . . . Malloy EJ. (2014). The NIOSH lifting equation and low-back pain, part 1: Association with low-back pain in the BackWorks prospective cohort study. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 56(1), 6-28. doi: 10.1177/0018720813486669

This article describes a prospective cohort study using the revised NIOSH lifting equation to predict risk of low-back pain (LBP). Both peak lifting index (PLI) and peak composite lifting index (PCLI) were significantly associated with increased risk of LBP. Both PLI and PCLI are useful metrics for estimating job physical exposure.

Krajnak KM, Waugh S, Miller GR, Johnson C. (2014). Recovery of vascular function after exposure to a single bout of segmental vibration. *Journal of Toxicology and Environmental Health* 77(17): 1061-1069.

Work rotation schedules may be used to reduce the negative effects of vibration on vascular function. This study determined how long it takes vascular function to recover after a single exposure to vibration in rats. Exposure to vibration exerted prolonged effects on peripheral vascular function, and altered vascular responses to a subsequent exposure. To optimize the positive results of work rotation schedules, it is suggested that studies assessing recovery of vascular function after exposure to a single bout of vibration be performed in humans.

Lowe BD, Albers J, Hudock SD. (2014). A biomechanical assessment of hand/arm force with pneumatic nail gun actuation systems. *International Journal of Industrial Ergonomics*, 44(5), 715-722. doi: 10.1016/j.ergon.2014.06.007

A biomechanical model is presented to estimate user hand/arm force exertion with two pneumatic nail gun trigger systems. The sequential actuation trigger (SAT) is safer than the contact actuation trigger (CAT) but increases the user's exertion of force because the trigger must be actuated after the safety tip is held pressed against the workpiece. The model shows that hand/arm force increases when nailing with the SAT (relative to CAT) and with a vertically-oriented workpiece (relative to horizontal). Depending upon idle holding duration, integrated hand force during tip contact was estimated to have been 1-3% of 48-132Ns total hand force with CAT and 21-44% of 83-167Ns total hand force with SAT (average of horizontal and vertical orientations). Based on standard time allowances from work measurement systems it is proposed that efficient application of hand force during tip contact with SAT can reduce this contribution to 6-15% of 55-139Ns total hand force.

Lowe BD, Albers J, Hudock SD. (2014, September). Hand/Arm Forces with Pneumatic Nail Gun Actuation Systems. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 58, No. 1, pp. 1575-1579). SAGE Publications. <http://dx.doi.org/10.1177/1541931214581328>

A biomechanical model is presented to estimate cumulative user hand/arm force associated with two pneumatic nail gun trigger systems. Application of the model shows the hand/arm force dependence upon the orientation of the workpiece in addition to the trigger system. Based on standard time allowances from work measurement systems (i.e. MTM - 1) the model results suggest that efficient application of tip contact force with the SAT would reduce total hand/arm force exertion attributable to this trigger system for this user.

Lowe BD, Dick RB. (2014). Workplace exercise for control of occupational neck/shoulder disorders: A review of prospective studies. *Environmental health insights*, 8(Suppl 1), 75.

A review was conducted of prospective studies (1997-2014) examining the efficacy of exercise as a workplace intervention to control neck/shoulder pain, symptoms, and disability. Specific resistance training (SRT) exercise appeared to be associated with more positive studies than other exercise modalities such as general resistance training, general physical exercise, stretching, and movement awareness exercises. The findings of this review suggest that workplace exercise can be effective as tertiary prevention and therapeutic relief of neck/shoulder symptoms, at least over the shorter term.

Lu ML, Dick R, Werren D, Lowe B. (2014). Bag handling assist controls for airport screening processes. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, EPHB 010-22a, p.1-24. <http://www.cdc.gov/niosh/surveyreports/pdfs/010-22a.pdf>

Through an inter-agency agreement, researchers from the National Institute for Occupational Safety and Health (NIOSH) were requested by the Transportation Security Administration (TSA) to conduct ergonomic assessments of a vacuum lifting assist device and of an automatic baggage moving system. We assessed the effectiveness of the two engineering controls in reducing the risk of low back disorders (LBDs) associated with baggage screening operations. Compared with complete manual baggage lifting, the reductions in the back compression forces were about 63% and 44% for the vacuum lift and the automatic baggage moving system, respectively. Findings of the risk assessments suggest that the two engineering controls have a great potential for reducing LBDs associated with manual baggage lifting and handling.

Lu ML, Waters TR, Krieg E, Werren D. (2014). Efficacy of the revised NIOSH lifting equation to predict risk of low-back pain associated with manual lifting: A one-year prospective study. *Human Factors*, 56(1), 73-85. doi: 10.1177/0018720813513608

The efficacy of the Revised National Institute for Occupational Safety and Health (NIOSH) lifting equation (RNLE) to predict risk of low back pain (LBP) was evaluated. The composite lifting index (CLI), the outcome measure of the RNLE for analyzing multiple lifting tasks, was used as the main risk predictor. Odds ratios (ORs) were calculated

using a logistic regression analysis adjusted for covariates that included personal factors, physical activities outside of work, job factors, and work-related psychosocial characteristics. The one-year self-reported LBP incidence was 32.1%. After controlling for history of prior LBP, supervisory support, and job strain, the categorical mean and maximum CLI above 2 had a significant relationship (OR = 5.1-6.5) with self-reported LBP, as compared with the CLI below or equal to 1.

NIOSH [2014]. Health hazard evaluation report: evaluation of ergonomic hazards at a label manufacturing facility. By Ramsey JG, Eisenberg J. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HHE Report No. 2012-0121-3225. <http://www.cdc.gov/niosh/hhe/reports/pdfs/2012-0121-3225.pdf>

NIOSH [2014]. Health hazard evaluation report: evaluation of ergonomic risk factors, thermal exposures, and job stress at an airline catering facility. By Ramsey JG, Musolin K, Ceballos D, Wiegand D, Mead K. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HHE Report No. 2011-0131-3221. <http://www.cdc.gov/niosh/hhe/reports/pdfs/2011-0131-3221.pdf>

Ramsey T, Davis KG, Kotowski SE, Anderson VP, Waters T. (2014). Reduction of spinal loads through adjustable interventions at the origin and destination of palletizing tasks. *Human Factors: The Journal of Human Factors and Ergonomics Society*, 56(7), 1222-1234. doi: 10.1177/0018720814528356

This article evaluates the effectiveness of two interventions: a self-leveling pallet carousel designed to position the loads vertically and horizontally at origin, and an adjustable cart designed to raise loads vertically at destination to reduce spine loads. The results showed that combining both devices results in reduction in spine compression (61%), anterior-posterior shear (72%), and lateral shear (63%) compared to traditional palletizing conditions. The combination of the interventions (self-leveling carousel and adjustable cart) was most effective in reducing the spine loads when compared to the traditional pallet-cart condition.

Waters TR, MacDonald LA, Hudock SD, Goddard DE. (2014). Provisional recommended weight limits for manual lifting during pregnancy. *Human Factors*, 56(1), 203-214. doi: 10.1177/0018720813502223

The National Institute for Occupational Safety and Health (NIOSH) Revised Lifting Equation (RNLE) was adapted to derive recommended weight limits (RWLs) for pregnant workers and to develop corresponding guidelines for clinicians. Practical authoritative guidelines based on accumulated evidence are needed to inform allowable work activity levels for healthy pregnant workers. Provisional RWLs for pregnant workers were derived from the RNLE, along with guidelines for clinicians. The guidelines advise against pregnant workers lifting below midshin and overhead. Implementation of these provisional guidelines could protect millions of female workers in the workplace from fetal and maternal lifting-related health problems.

Welcome DE, Dong RG, Xu XS, Warren C, and McDowell TW. (2014). The effects of vibration-reducing gloves on finger vibration. *International Journal of Industrial Ergonomics* 44: 45-59

The objectives of this study are to determine whether vibration-reducing (VR) gloves can attenuate the vibration transmitted to the fingers and to enhance the understanding of the mechanisms of how these gloves work. This study enhanced the understanding of the glove effects on finger vibration and provided useful information on the effectiveness of typical VR gloves at reducing the vibration transmitted to the fingers. The new results and knowledge can be used to help select appropriate gloves for the operations of powered hand tools, to help perform risk assessment of the vibration exposure, and to help design better VR gloves.

Wu JZ, Dong RG, Warren CM, Welcome DE, and McDowell TW. (2014). Analysis of the effects of surface stiffness on the contact interaction between a finger and a cylindrical handle using a three-dimensional hybrid model. *Medical Engineering & Physics* 36: 831-841.

Contact interactions between the hand and handle, such as the contact surface softness and contact surface curvature, will affect both physical effort and musculoskeletal fatigue, thereby the comfort and safety of power tool operations. Previous models of hand gripping can be categorized into two groups: multi-body dynamic models and finite element (FE) models. The goal of the current study is to develop a hybrid FE hand gripping model, which combines the features of conventional FE models and multi-body dynamic models. Our results show that the maximal compressive stress and strain in the soft tissues of the fingers can be effectively reduced by reducing the stiffness of the covering material.

Wu JZ, Sinsel EW, Shroyer JF, Warren CM, Welcome DE, Zhao KD, An KN, Buczek FL. (2014). Analysis of the musculoskeletal loading of the thumb during pipetting—a pilot study. *J Biomech* 47(2): 392-399.

Previous epidemiological studies indicate that the use of thumb-push mechanical pipettes is associated with musculoskeletal disorders (MSDs) in the hand. The goal of the current study was to analyze the loading in the muscle-tendon units in the thumb during pipetting. The analysis method and results in the current study provide a mechanistic understanding of MSD risk factors associated with pipetting, and may be useful in guiding ergonomic designs for manual pipettes.

Xu XS, Dong RG, Welcome DE, McDowell TW, Wu JZ, Wimer B, Warren C. (2014). An examination of the handheld adapter approach for measuring hand-transmitted vibration exposure. *Measurement* 47: 64-77.

The use of a handheld adapter equipped with a tri-axial accelerometer is the most convenient and efficient approach for measuring vibration exposure at the hand-tool interface, especially when the adapter is incorporated into a miniature handheld or wrist-strapped dosimeter. To help optimize the adapter approach, the specific aims of this study are to identify and understand the major sources and mechanisms of measurement errors and uncertainties associated with using these adapters, and to explore their improvements. The results of this study suggest that measurement errors can be substantially reduced if the design and use of an adapter can be systematically optimized toward minimizing the combined effects of the identified factors.

Select 2013 Publications

Dong RG, Welcome DE, McDowell TW, and Wu JZ. (2013). Modeling of the biodynamic responses distributed at the fingers and palm of the hand in three orthogonal directions. *Journal of Sound and Vibration* 332: 1125-1140.

The objectives of this study were to develop models of the hand-arm system in the three orthogonal directions and to enhance the understanding of the hand vibration dynamics. A four-degrees-of-freedom (DOF) model and 5-DOF model were used in the simulation for each direction. The 5-DOF models were generally superior to the 4-DOF models for the simulation. Hence, as examples of applications, the 5-DOF models were used to predict the transmissibility of a vibration-reducing glove and the vibration transmissibility on the major substructures of the hand-arm system. Some interesting phenomena observed in the experimental study of the biodynamic responses in the three directions were also explained in this study.

Dong RG, Welcome DE, McDowell TW, and Wu JZ. (2013). Theoretical relationship between vibration transmissibility and driving-point response functions of the human body. *Journal of Sound and Vibration* 332(24): 6193-6202.

The relationship between the vibration transmissibility and driving-point response functions (DPRFs) of the human body is important for understanding vibration exposures of the system and for developing valid models. This study identified their theoretical relationship and demonstrated that the sum of the DPRFs can be expressed as a linear combination of the transmissibility functions of the individual mass elements distributed throughout the system. This study also clarified the requirements for reliably quantifying transmissibility values used as references for calibrating the system models. The basic theory developed in this study is also applicable to the vibration analyses of other structures.

Krajnak KM, Waugh S, Johnson C, Miller GR, Xu XS, Warren C, Dong RG. (2013). The effects of impact vibration on peripheral blood vessels and nerves. *Industrial Health* 51: 572-580.

This study used an established animal model of vibration-induced dysfunction to determine how exposure to impact vibration affects peripheral blood vessels and nerves. Impact vibration did not alter vascular responsiveness to any factors or affect trunk nerves. However, 4 days following exposure there was an increase in proteingene product (PGP) 9.5 staining around hair follicles. A single exposure to impact vibration, with the exposure characteristics described above, affects peripheral nerves but not blood vessels.

Lowe B, Albers J, Hudock S, Krieg E. (2013). Finger tendon travel associated with sequential trigger nail gun use. *IIE Transactions on Occupational Ergonomics and Human Factors*, 1(2), 109-118.

This study developed a method to predict cumulative finger flexor tendon travel associated with the sequential actuation trigger-equipped pneumatic nail gun from finger joint kinematics measured in the trigger actuation and productivity standards for wood frame construction tasks. Finger flexor tendon travel was attributable mostly to PIP and DIP joint motion. Tendon travel per nail fired appeared to be slightly greater for a wall-building task than a flat nailing task. Results suggest that exposure to finger tendon travel from nail gun use may be below levels that have been previously associated with high musculoskeletal disorder risk.

Lu ML, Swanson NG, Nakata A, Park JB. (2013). Workplace psychosocial factors associated with work-related injury absence: A study from a nationally representative sample of Korean workers. *International Journal of Behavioral Medicine*, 1-11. doi: 10.1007/s12529-013-9325-y

This study aims to assess the association of comprehensive workplace psychosocial factors with work-related injury absence among Korean workers. The overall 1-year prevalence of work-related injury absence in this study was 1.37 % (95 % CI, 1.11–1.63 %). Those who experienced violence at work (adjusted odds ratio (aOR), 7.05 (95 % CI, 2.69-18.5)), threat of violence at work (aOR, 4.25 (95 % CI, 1.32-13.64)), low job autonomy (aOR, 1.79 (95 % CI, 1.17-2.74)), and high job strain (aOR, 2.38 (95 % CI, 1.29-4.42)) had an increased risk of injury absence, compared with their respective counterparts ($p < 0.05$). Among all job types, skilled workers in Korea were at a near fourfold risk of work absence due to occupational injuries, compared with managers in low-risk jobs.

MacDonald LA, Waters TR, Hudock SD, Napolitano PG, Nielsen P, Goddard DE, Ryan MA. (2013). Clinical guidelines for occupational lifting in pregnancy: Evidence summary and provisional recommendations. *American Journal of Obstetrics and Gynecology*, 209(2), 80-88. doi: 10.1016/j.ajog.2013.02.047

Empirically-based lifting criteria established by the National Institute for Occupational Safety and Health (NIOSH) to reduce risk of overexertion injuries in the general U.S. working population were evaluated for application to pregnant workers. This report proposes criteria to guide decisions by medical providers about permissible weights for lifting tasks performed at work over the course of an uncomplicated pregnancy. Provisional clinical guidelines derived from the NIOSH lifting criteria are presented that account for recent evidence for maternal and fetal health, and aim to improve the standard of care for pregnant workers.

McDowell TW, Dong RG, Welcome DE, Warren C, and Xu XS (2013). Vibration-reducing gloves: transmissibility at the palm of the hand in three orthogonal directions. *Ergonomics* 56(12): 1823-1840.

This study used human subjects to measure three-dimensional vibration transmissibility of vibration-reducing gloves at the palm and identified their vibration attenuation characteristics. This study found the gloves to be most effective at reducing vibrations along the forearm direction. These gloves did not effectively attenuate vibration along the handle axial direction.

McDowell TW, Welcome DE, Warren C, Xu XS, and Dong RG. (2013). Assessment of Hand-Transmitted Vibrations from Vibrating Forks Used for Beach Cleaning Operations. *Annals of Occupational Hygiene* 57(1): 43-53.

Motorized vibrating manure forks were used in beach-cleaning operations following the massive Deepwater Horizon oil spill in the Gulf of Mexico during the summer of 2010. The objectives of this study were to characterize the vibration emissions of these motorized forks and to provide a first approximation of hand-transmitted vibration exposures to workers using these forks for beach cleaning. Acceleration was found to increase with motor speed. Thus, workers should consider operating these tools with just enough speed to get the job done. The results also suggest that the motor should not be operated with the fork in the unloaded state. Anti-vibration gloves are not effective at attenuating the vibration frequencies produced by these forks, and they may even amplify the transmitted vibration and increase hand/arm fatigue.

NIOSH [2013]. Health hazard evaluation report: evaluation of musculoskeletal disorders and traumatic injuries among employees at a poultry processing plant. By Musolin K, Ramsey J, Wassell J, Hard D, Mueller C. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HHE Report No. 2012-0125-3204. <http://www.cdc.gov/niosh/hhe/reports/pdfs/2012-0125-3204.pdf>

NIOSH [2013]. Health hazard evaluation report: evaluation of vibration exposure for interment technicians. By Ramsey J, Lowe B, Werren D. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, NIOSH HETA No. 2011-0166-3175. <http://www.cdc.gov/niosh/hhe/reports/pdfs/2011-0166-3175.pdf>

Wu JZ, Sinsel EW, Shroyer JF, Welcome DE, Zhao KD, An KN, Buczek FL (2013). The musculoskeletal loading profile of the thumb during pipetting based on tendon displacement. *Med Eng Phys* 35(12): 1801-1810.

Strong evidence indicates that highly repetitive manual work is associated with the development of upper extremity musculoskeletal disorders (MSDs). One of the occupational activities that involves highly repetitive and forceful hand work is manual pipetting in chemical or biological laboratories. In the current study, we quantified tendon displacement as a parameter to assess the cumulative loading exposure of the musculoskeletal system in the thumb during pipetting. Our results showed that tendon displacements may be useful in evaluating the musculoskeletal loading profile.